

REACTIVE ION ETCHING OF MULTIPHASE STRUCTURES FOR CARBON-DERIVED CARBON SYNTHESIS

P. Gupta, M. Tlustochowicz, R. Zhu, C. White, M. McNallan, A. Erdemir, B. Prorok, Y. Gogotsi

University of Illinois at Chicago

Abstract

Carbide Derived Carbon (CDC) is produced by selective removal of metals from metal carbides by high temperature etching in halogen containing gases at atmospheric pressure. In a multi-phase structure, the relative affinity of the metal for the halogen will determine which phase is selectively etched and which phase is relatively unaffected by the presence of the halogen. In some practical cases, this selective attack can be a hindrance to the formation of useful CDC layers. For example, most WC components are cemented carbide materials containing Co or Ni binders. At elevated temperatures, selective attack of the metal binder occurs more rapidly than conversion of WC to CDC, leading to damage of the surface before a CDC layer can form. In the context of SiC based MEMS devices fabricated on Si wafer substrates, high temperature chlorine gases etch the elemental Si more rapidly than they convert SiC to CDC, so that it is difficult to produce CDC layers on these devices.

As an alternative to high temperature treatment, the materials can be etched at lower temperatures in a reactive halogen ion plasma at reduced pressure. Rather than reaching local equilibrium on a microscale resulting in selective attack of the more reactive component of the structure, the halogen radicals tend to react immediately upon encountering the surface and the metal halide species are removed producing a more uniform reaction front. Reactive ion etching has been used to produce carbon layers on multiphase carbide materials containing silicon, titanium, and tungsten. The resulting carbon layers have been characterized using a variety of techniques.